Question: a 72.0-kg man is riding an escalator in a shopping mall. The escalator moves the man at a constant velocity from ground level to the floor above, a vertical height of 5.20 m. What is the work done on the man by (a) the gravitational force and (b) the escalator?

Solution: we will use the law of the conservation of the energy solving this problem. The only external force that acts on the man is the gravitational force $F_g = mg$. This force is directed downwards, so the escalator that moves the man from ground level to the floor above is working against the gravitational force and the work done by the escalator is positive. The potential energy of the man that is at height h above the ground level is $U = mgh$. Thus the work done by the escalator $A_{escalator}$ is equal the change in the potential energy of the man.

$$A_{escalator} = mgh = 72.0 \cdot 5.20 \cdot 9.81 \cong 3.67 \ kJ.$$

The work done by the gravitational force $A_{gravitational}$ has the same absolute value as the work done by the escalator but with opposite sign, because the man is moving upwards (against the direction of the gravitational force).

$$A_{gravitational} = -A_{escalator} = -3.67 \ kJ.$$

Answer:

(a) Work done on the man by the gravitational force is $A_{gravitational} = -mgh = -3.67 \ kJ.$

(b) Work done on the man by the escalator is $A_{escalator} = mgh = 3.67 \ kJ.$